Christian-Albrechts-Universität zu Kiel
Agrar- und Ernährungswissenschaftliche Fakultät

Biogas-Expert: Nitrous oxide emission from biogas production systems on a coastal marsh soil

Techow A., Dittert K., Senbayram M., Quakernack R., Pacholski A., Kage H., Taube F., Herrmann A.

Agricultural Faculty, Christian-Albrecht University, Kiel, Germany

Background and Objectives

Biogas production has greatly expanded in Germany, but knowledge about its environmental effects is still insufficient. The objectives of the present study were (i) to quantify the N_2O emission from grassland and two cropping sequences of maize-winter wheat and wheat-Italian ryegrass for a typical marsh site in Northern Germany, and (ii) to analyse the N_2O impact of fertiliser type, i.e. biogas residue vs. mineral fertiliser

Material and Methods

- N_2O emission measured from April til Dec 2009 on a clayic soil (25-30% clay, Fluvimollic Gleysol, pH 7.0) close to the west coast of Schleswig-Holstein, using the closed chamber method
- Impact of cropping sequence (grassland, maize-winter wheat, wheat-Ital. ryegrass and N fertilisation (control, calcium ammonium nitrate (CAN), biogas residue) tested in a block design with four replicates
- N rates: 480 kg N ha^{-1} (4-cut grassland), 240 kg N ha^{-1} (winter wheat), 200 kg N ha^{-1} (maize), and 80 kg N ha^{-1} (Ital. ryegrass)
- N_2O Determination: gas chromatograph (Varian)
- Accumulation: linear interpolation between measured daily fluxes
- Statistical Analysis: SAS Proc Mixed (fixed factors: replicate, crop, fertilisation treatment, crop x fertilisation interaction)
- Multipe comparison by Tukey-Kramer method

Results

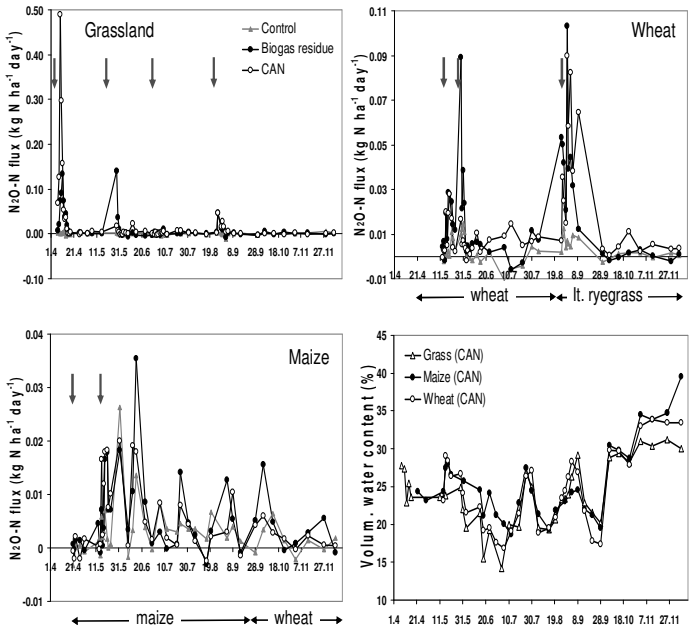

Fig. 1. Daily N_2O-N fluxes monitored from April to Dec. 2009 for different crops and fertiliser treatments, and soil volumetric water content (upper 10 cm). Maize: maize-winter wheat cropping sequence, wheat: wheat(*)-Italian ryegrass sequence. (*summer wheat, since unfavourable conditions in autumn 2008 prevented sowing of winter wheat). Arrows indicate fertilisation events

Tab. 1. Cumulative N_2O emission (kg N_2O-N ha^{-1}) from April to Dec. 2009 for different crops and fertiliser treatments. Maize: maize-winter wheat cropping sequence, wheat: wheat(*)-Italian ryegrass sequence. (*summer wheat, since unfavourable conditions in autumn 2008 prevented sowing winter wheat)

Crop/fertiliser treatment	Grassland	Maize	Wheat	Mean
Control	0.22	0.93	0.21	0.45 a
Mineral N (CAN)	2.00	1.15	2.43	1.86 b
Biogas residue	1.74	1.18	1.49	1.47 b
S.E.	0.44	0.44	0.44	0.25

- Nitrous oxide flux pattern mostly followed the fertilisation events in all crops (Fig. 1)
- Staistical analysis of cumulative N_2O emission revealed a significant effect of fertiliser treatment (Tab. 1)
- Ratio of N_2O-N loss to N-input was below the 1% IPCC default value in all treatments
- It seems, that this finding is attributable to low soil moisture

Conclusions

- Our hypothesis that biogas substrate production on a marsh soil will cause high N_2O emission was not confirmed, probably due to low precipitation
- A comprehensive analysis, taking all N-flows into account and supplemented by simulation models will provide more detailed insights into the underlying processes

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